4 OPERATIONAL CONCEPTS AND SCENARIOS

The term “operational concept” generally means “how a system is used in various operational scenarios”. “System” is used here in a broad sense to include people and manual processes as well as automated information, sensors, and control systems. New operational concepts are adopted in order to solve a problem in the current operations or to take advantage of new knowledge or technology that enables improvements in current operations.

The operational concepts in this section are related to the guiding principles developed by the stakeholder community. The concepts were derived by first analyzing the user services that discuss how to improve commercial vehicle operations, then interpreting the stakeholder-developed guiding principles, and finally applying knowledge about the state of existing and emerging technologies. The combination of the desired commercial vehicle operations improvements, guiding principles about making those improvements, and the reality of technological advances are reflected in the operational concepts.

CVISN electronic screening operational concepts include necessary steps toward achieving the goal of national interoperability among electronic screening systems. Realizing this goal will promote seamless and safer movements, equitable treatment, increased productivity, and uniform enforcement for the motor carrier community.

4.1 Key Operational Concepts

The CVISN Operational and Architectural Compatibility Handbook (COACH) Part 1, Operational Concept and Top-Level Design Checklists (Reference 9), includes a comprehensive checklist of key operational concepts relating to Electronic Screening. The operational concepts should be used to guide the state design process. The electronic screening operational concepts stated in the COACH Part 1 are:

<u>Widespread participation in electronic screening programs is encouraged.</u> A basic Intelligent Transportation Systems (ITS)/CVO Guiding Principle is voluntary participation. If motor carriers do not choose to equip their vehicles with DSRC transponders, then electronic screening can not occur. States must actively market their electronic screening programs to increase the population of transponder-equipped vehicles. To the extent possible, enrollment restrictions should be minimized in order to maximize the eligible population of vehicles.

<u>Jurisdictions disclose practices related to electronic screening.</u> The *ITS/CVO Interoperability Guiding Principles* (Reference 10) and the *Fair Information Principles for ITS/CVO* (Reference 11), both adopted by the Intelligent Transportation Society of America (ITSA) CVO Technical Committee, advise jurisdictions to fully disclose electronic screening practices and policies. The disclosure should include the following information:

- Enrollment criteria
- Transponder unique identifier standards
- Price and payment procedures for transponders and services
- Screening standards

- Use of screening event data
- Business interoperability agreements with other programs

Electronic screening is provided for vehicles equipped with FMCSA-specified DSRC transponders. For the immediate future, all CVO and Border Crossing projects will continue to utilize ASTM v6 active transponders and readers. In the long term, systems should migrate to equipment conforming to the sandwich specification (see Section 3.4.1).

Credentials and safety checks are conducted as part of the screening process. Credential and safety data from SAFER/CVIEW carrier and vehicle snapshots should be used in the screening algorithm.

Fixed and/or mobile roadside check stations are employed for electronic clearance functions, according to the jurisdiction's needs and resources. Deployment of electronic screening in each jurisdiction is unique because of variations in policies and practices, geography, traffic flow and volume, site configuration and characteristics, legacy system characteristics, existing roadside and communications equipment, and available resources.

Jurisdictions support a common set of screening criteria. A common performance standard for electronic screening is desired to ensure equity in enforcement. However, carriers and vehicles must continue to meet all legal requirements established by the jurisdiction.

Screening systems are interoperable with those in different jurisdictions. National interoperability of electronic screening systems is the goal of USDOT and provides maximum benefit to both the states and the motor carrier industry.

4.2 Electronic Screening Functions

4.2.1 Electronic Screening Enrollment

Prior to participation in e-screening programs, the carrier, vehicle and transponder information must be provided through an enrollment process. By restricting each transponder to installation on a specific vehicle, a direct relationship is established between the transponder ID and the vehicle identification number (VIN). Vehicle snapshots contain a transponder ID field to record this information. SAFER restricts access of the transponder ID fields to only those states requested by the motor carrier. To support this capability, elements have been added to the carrier and vehicle snapshots, designating the jurisdictions that are granted access to the transponder ID field. This request/permission information is submitted along with the vehicle VINs and corresponding transponder IDs during the E-screening enrollment process.

When applying to an electronic screening program, the motor carrier may also request participation in other screening programs or states. The jurisdiction request elements and transponder IDs in the snapshots are updated, during the enrollment process, and sent to SAFER. The requests are then forwarded to the external jurisdictions via the SAFER subscription process.

As transponder-equipped vehicles approach the roadside station, the transponder IDs are read using DSRC. The E-screening system uses the transponder ID to uniquely identify the corresponding vehicle (VIN). The VIN relates to a vehicle snapshot, which contains the default carrier ID. Safety and credential checks can then be made using the appropriate carrier and vehicle snapshots.

4.2.2 Electronic Screening Algorithm

There are four major components to the recommended electronic screening algorithm:

1. Weight and size screening
2. Safety screening on the carrier and vehicle safety history derived from snapshots
3. Credentials screening, based on specific credential violations or history information contained in snapshots
4. A random selection factor to randomly pull in a selected percentage of vehicles

Selection for pull-in should be made even if only one component denies bypass, regardless of the other conditions.

4.2.2.1 Weight and Size Screening

The purpose of weight and size screening is to ensure compliance with these regulations. Three basic methods are discussed here: sensor data, prior event data or compliance history.

4.2.2.1.1 Weight and Size Screening with Sensors

Weight screening may be based on the weight estimates from the WIM sensors mounted either on the ramp or mainline. There are several elements to this method of weight and size screening:

- A weight pass/fail threshold set to some percent of the legal or registered weight
- A check of vehicle speed, position, or other factors that may void the WIM reading
- Overall vehicle size based on AVC
- An over height detector

These sensor inputs are used as a real-time estimate of vehicle compliance.

4.2.2.1.2 Weight Screening Using Prior Event Data

The results of a prior screening event stored on the DSRC tag, or forwarded from an upstream station, may be used to grant a bypass at the current station. This method assumes that a vehicle has previously been weighed at a station equipped with either WIM or static scale. The date and time of the previous event are checked to ensure that the data are current.

4.2.2.1.3 Weight Screening Based on Compliance History

Compliance history can be used as an effective and economical method of enforcement in lieu of constantly weighing vehicles. Historical data may be used to rate carriers and vehicles on their demonstrated compliance with size and weight restrictions. These ratings could form the basis for a pull-in probability, rewarding operators who have maintained a good weight compliance record with more frequent bypasses than those that have performed poorly. Weight compliance information is being considered for inclusion in the snapshots.

4.2.2.2 Safety Screening

Safety screening should be based on SafeStat carrier safety ratings and inspection history data derived from SAFER/CVIEW snapshots. The goals of safety screening are:

- To focus resources on those carriers and vehicles with poor safety histories
- To provide a benefit to those carriers that have good safety histories
- To provide incentive for carriers to maintain safe vehicles and safe driving practices

To meet the goals defined above, the selection process should be weighted to pull in mostly unsatisfactory or unidentified vehicles, while stopping only a small portion of the transponder-equipped DSRC vehicles not otherwise flagged by the screening algorithm. The continued occasional sampling of all vehicles will provide the incentive to maintain a good safety rating.

4.2.2.3 Credential Screening

Credential screening looks for vehicles that have very specific inspection or review needs. The following snapshot data elements should be included in the credential check:

- Missing or invalid credentials
- International Fuel Tax Agreement (IFTA) check status for carrier
- International Registration Plan (IRP) or trip permit status for vehicle
- Manual selection for specific carrier or vehicle

The elements incorporated into a specific credential screening algorithm should be tailored to the requirements, enforcement authority, and objectives of the particular jurisdiction.

4.2.2.4 Random Selection Component

The random selection component can serve several purposes, including random viewing for visual inspection selection, expanded data collection and compliance monitoring. Even the best-rated operators should be occasionally examined to verify their continued compliance. Jurisdictions with “probable cause” legislation in effect should check the legality of using a random selection component. It may be necessary to eliminate the random element to comply with the law.

It may be valuable to allow the site operator to have control over the overall screening rates and the resulting traffic flow through the station. A “control valve” factor can be applied, referred to as the “maximum random sort rate.” This factor can be applied to adjust the pull-in rate for all vehicles by an equal amount. The actual pull-in rate for any individual vehicle would be the product of the screening pull-in rate and the maximum random sort rate. If there is any clear reason for pull-in (other than random), such as a weight or credential violation, that would take precedence.

4.2.3 Mainline Screening

Mainline screening allows vehicles to be cleared without pulling into the station. DSRC readers and sensors are located far enough ahead of the station ramp so that the screening system has time to complete all necessary processing as the vehicle approaches. A signal is transmitted to the DSRC transponder in the vehicle to signal the screening decision to the driver.

The advantages of screening on the mainline are to reduce traffic volume entering the station facility and to minimize the delay for safe and legal vehicles. A disadvantage is that in-road equipment repairs on the mainline can be very costly and disruptive. If mainline WIM is used, it will not be as accurate as either a static scale or ramp WIM, although the weight estimates should be sufficient to clear a significant portion of the vehicle traffic.

4.2.4 Ramp Screening

Ramp screening is performed at lower speeds within the confines of the station and approach ramp. Upon entering the approach ramp, vehicles are identified and screened. Bypassed vehicles will be directed to proceed back to the mainline after only a brief delay. The remainder will be required to proceed to the static scales.

4.2.5 In Cab Notification (ICN)

Vehicles equipped with a DSRC tag can receive visual and audio signals informing the driver of the screening decision. This is done by a DSRC command sent, by the reader to the vehicle tag, to set the audio and visual indicators on the tag. The driver should bypass only on receipt of green signal and tone. If a red signal is received, then the driver must pull in unless roadside signs specifically show the station is closed. If no signal is received, the driver should obey the station roadside signs. These guidelines should handle situations where the station is otherwise closed, the DSRC operations are secured, the tag fails to receive the message, or the equipment malfunctions. ICN is typically used in mainline screening systems.

4.2.6 Lane Signals

Within the station perimeter, off the mainline road, all vehicles should see automated lane signals such as those indicating whether to proceed to the static scale, or whether to return to mainline. All vehicles are expected to follow the lane signals. ICN should not be used within the station where conflicts may arise between the ICN and the lane signals.

4.2.7 Compliance Checking

Prior to the addition of mainline screening, station operators could easily detect individual vehicles that bypass the station in violation of the signs. However, when mainline screening and ICN are used, it is not obvious to the station personnel when a particular vehicle has been cleared to bypass. AVC equipment is used to cover all mainline lanes and detect any commercial vehicles that bypass the station. A DSRC reader, collocated with the AVC, should interrogate the transponders on vehicles which bypass the station, to verify that they are in compliance with the ICN signal. The compliance system should be positioned past the station entrance but before the return for traffic processed through the station.

4.3 Operational Scenario

The e-screening system being deployed at Perryville, Maryland is described in this section along with the associated operational scenario. This site is unique because it will include both mainline and ramp screening systems. Due to cost, most electronic screening systems are either mainline-only or ramp-only. Maryland has elected this dual-capability configuration in order to compare the relative performance of the two methods.

The listed scenario describes the combined operation of the two subsystems and function of the various components. The operational scenario for a ramp-only or mainline system can easily be derived from the information presented.

4.3.1 Site Layout

Figure 4-1 illustrates the site layout for the E-screening system being deployed at Perryville, MD. All major roadside equipment components are shown in the figure. The key features of this layout are:

- Mainline Piezo WIM/AVC in the right-hand southbound lane on I-95, approximately 1 mile upstream of the station
- Over-height detector collocated with Mainline WIM
- DSRC reader (Advance) collocated with Mainline WIM
- DSRC reader (Notification) located approximately ¼ mile upstream of the ramp approach. The location of the Notification Reader must allow sufficient time for the vehicle operator to receive the bypass/pull-in signal via DSRC and safely maneuver back onto I-95 or pull-in to the static scale
- AVCs across all three South-bound lanes of I-95, downstream of the station ramp.
- DSRC reader (Compliance) collocated with AVCs. The compliance readers shall cover only the right-hand lanes on I-95. Trucks will be restricted to these lanes when bypassing the station
- Load-cell WIM in ramp lane
- DSRC reader (Ramp) on ramp, upstream of WIM
- Over-height detector installed near Ramp Reader
- Overhead signs directing traffic back to I-95 or onto the static scale
- DSRC reader (Static Scale) collocated with the station static scale
- Tracking loops installed as necessary

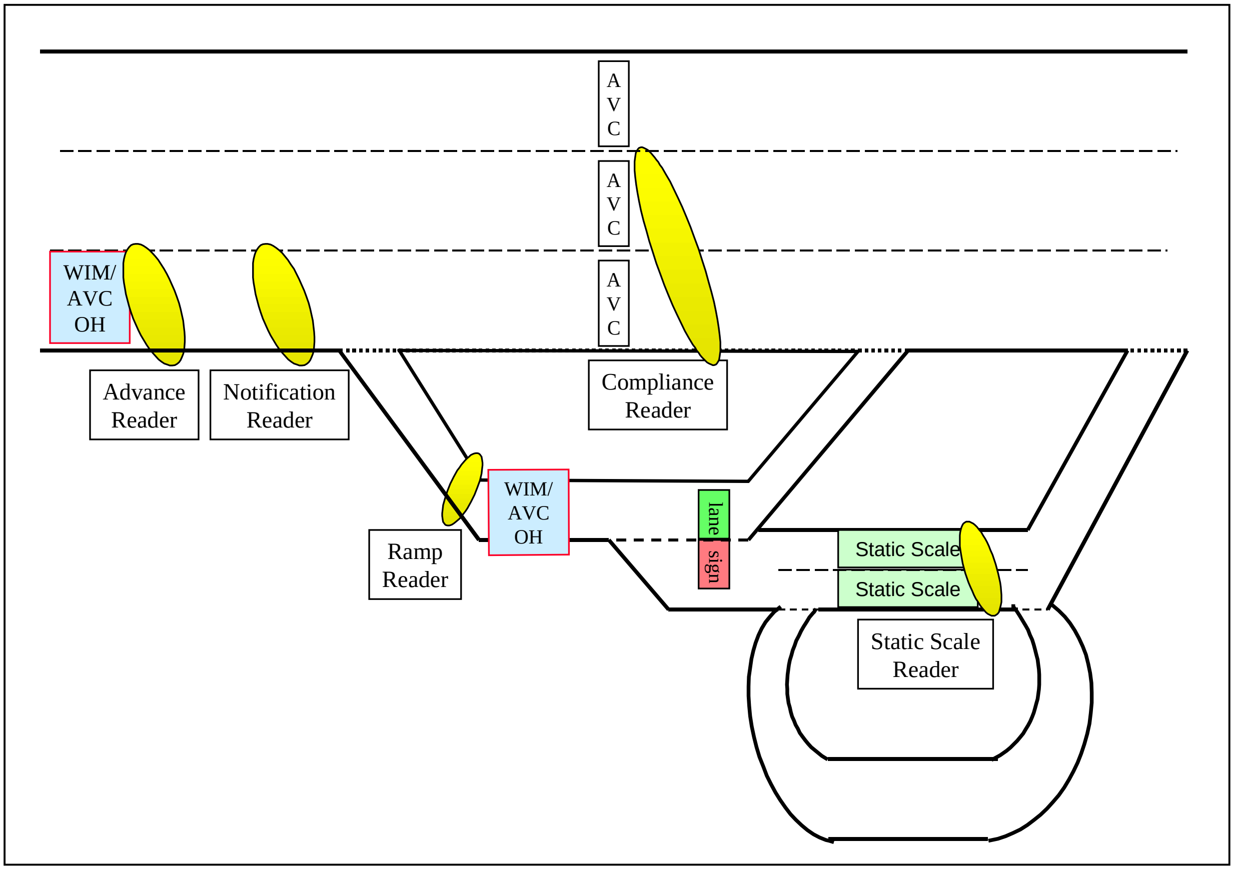

Figure 4–1. Perryville, Maryland Site Layout

4.3.2 E-Screening Operational Scenario

In the site layout shown in Figure 4-1, there are five DSRC readers along with both ramp and mainline WIM. The five DSRC readers shown in this configuration are: Advance Reader, Notification Reader, Compliance Reader, Ramp Reader and Static-Scale Reader.

The Advance Reader's function is to read the screening message, including the carrier and vehicle identifiers, and to send this information to the screening computer for use in determining whether to clear the vehicle without pulling into the station. The reader is located far enough ahead of the Notification Reader so that the mainline screening subsystem has time to complete all necessary processing as the vehicle approaches. The advantages of screening on the mainline are to control traffic volume entering the station facility and to minimize the delay for safe and legal vehicles.

The mainline WIM/AVC provide vehicle weight estimates as input to the mainline screening decision. Gross vehicle weight along with axle weights and spacing are available. Although not as accurate as either a static scale or ramp WIM, the weight estimates are sufficient to clear a significant portion of the vehicle traffic.

At the Notification Reader, a signal is transmitted to the vehicle to convey the screening decision status to the driver. Since a DSRC-equipped vehicle could be signaled to pull in, the Notification Reader must be deployed far enough from the roadside check facility for the vehicle's driver to be able to react without endangering other vehicles on the roadway. Reaction time budgets should account for slowing and turning off the mainline, as well as crossing lanes of traffic.

By the time the vehicle has passed the Advance and Notification Readers, it has been electronically cleared. However, it is also necessary to verify that vehicles are not illegally bypassing a check station. Therefore, a Compliance Reader and an AVC system are located on the mainline, past the entrance ramp to the station. The AVC identifies un-tagged commercial vehicles that have illegally passed the station. The reader checks tagged vehicles to verify that the vehicle was cleared to bypass the station. If a violation is detected, an indication is given to enforcement personnel.

Vehicles entering the check facility ramp would fall into one of the following categories:

- DSRC-equipped, valid legal weight – the vehicle has been identified via DSRC, a valid weight has been recorded and an active screening decision has been made to stop the vehicle for some type of closer review. This may be based on specifically identified problems, or may be due to random selection. Closer review may be limited to a visual check while on the static scale, or may include an inspection based on the visual review, on data reported back in the screening process, or on random selection.
- DSRC-equipped, invalid or over weight – the vehicle has been identified via DSRC, however, either the WIM failed to properly register the weight or the detected weight exceeded the criteria.
- DSRC-equipped, unrecognized – the vehicle is equipped with a transponder, however, the tag may either be incompatible with or not valid for use at the site.
- No DSRC.

Upon entering the facility ramp, vehicles will be processed by the ramp WIM. The DSRC Ramp Reader would interrogate the vehicle tag to retrieve the relevant identification data. A screening decision would be made and the vehicle would be subsequently directed by visual lane signals. Cleared vehicles would be signaled to return to the mainline. Vehicles receiving a pull-in decision on the ramp would be directed to the static scale. The Static-Scale Reader is used to identify transponder-equipped vehicles that are on the scale. Snapshot-based safety and credential data for the vehicle would be available to the static scale operator.

4.4 Functional Thread Diagram

A state must develop or otherwise acquire new systems and modify some existing systems to implement the CVISN Level 1 capabilities. There are many ways to do this and still be in conformance with the architecture and standards. Chapter 6 illustrates several approaches to electronic screening that are consistent with the architecture.

Regardless of the design approach chosen, all states need to model their intended business processes in a way that is easy for all stakeholders to review and understand. The functional thread diagram is the tool recommended to illustrate operational scenarios.

This section depicts an example functional thread diagram. The scenario chosen is one of the CVISN Level 1 capabilities. The high-level CVISN Level 1 operational scenarios related to electronic screening are listed below:

- Query for a snapshot
- Screen vehicles electronically at least one weigh station/inspection site, using snapshots

The example illustrates the basic function of electronically screening a vehicle. The method used to demonstrate the scenario is called a "functional thread diagram." The activities in the scenario are listed as steps. To differentiate between different time schedules, numbers are used to show the steps which occur in real time as a vehicle passes through the station. Letters are used to show the transfer of the screening data down to the roadside station, since that occurs in advance of the screening events.

A diagram corresponding to the steps listed is presented in Figure 4-2 for a graphical view of the scenario. The lines represent data flow between products, with arrows indicating the direction of flow. Each line is labeled with a number or letter. The complete set of lines constitutes a thread of activities that accomplish a function. Hence, the diagram is called a "functional thread diagram."

Additional examples of operational scenarios and functional thread diagrams are in Appendix B. They are included for reference, and as starting points for states that plan to implement similar processes.

4.4.1 Example Scenario: Screen Vehicles Electronically Using Snapshots

The following steps (A–C) occur on a periodic basis to establish screening values for the site:

A. SAFER sends subscription updates to the state CVIEW for carrier and vehicle snapshots, based on state-specified subscriptions. These snapshots are sent as TS 285 transactions.
B. CVIEW distributes carrier and vehicle snapshots to roadside sites, also based on specified subscriptions. These are also sent as TS 285 transactions.
C. Enrolled vehicles are identified from the snapshots. Site operators may interact with Roadside Operations to control local screening criteria, which will be based on the snapshot information. The resulting carrier and vehicle specific screening "scores" or values are sent to the screening system. This is a local interface that is not subject to standards.

The following steps (1–4) are steps that occur in real time for each vehicle:

1. Transponder ID (or carrier and vehicle specific identifiers) is transmitted from the DSRC transponder on board the Commercial Vehicle to the Sensor/Driver Communications interface using an ASTM version 6 reader.
2. If carrier and vehicle identifiers are used, the identifiers are extracted from the DSRC message in accordance with the IEEE P1455 message set for use in the Screening system. A screening decision is made based on snapshot data and sensor inputs.
3. The screening decision is communicated back to the driver, again using the ASTM version 6 standards and the IEEE P1455 message set.
4. Screening information is communicated back to Roadside Operations for use by site staff. This is a local interface that is not subject to standards.

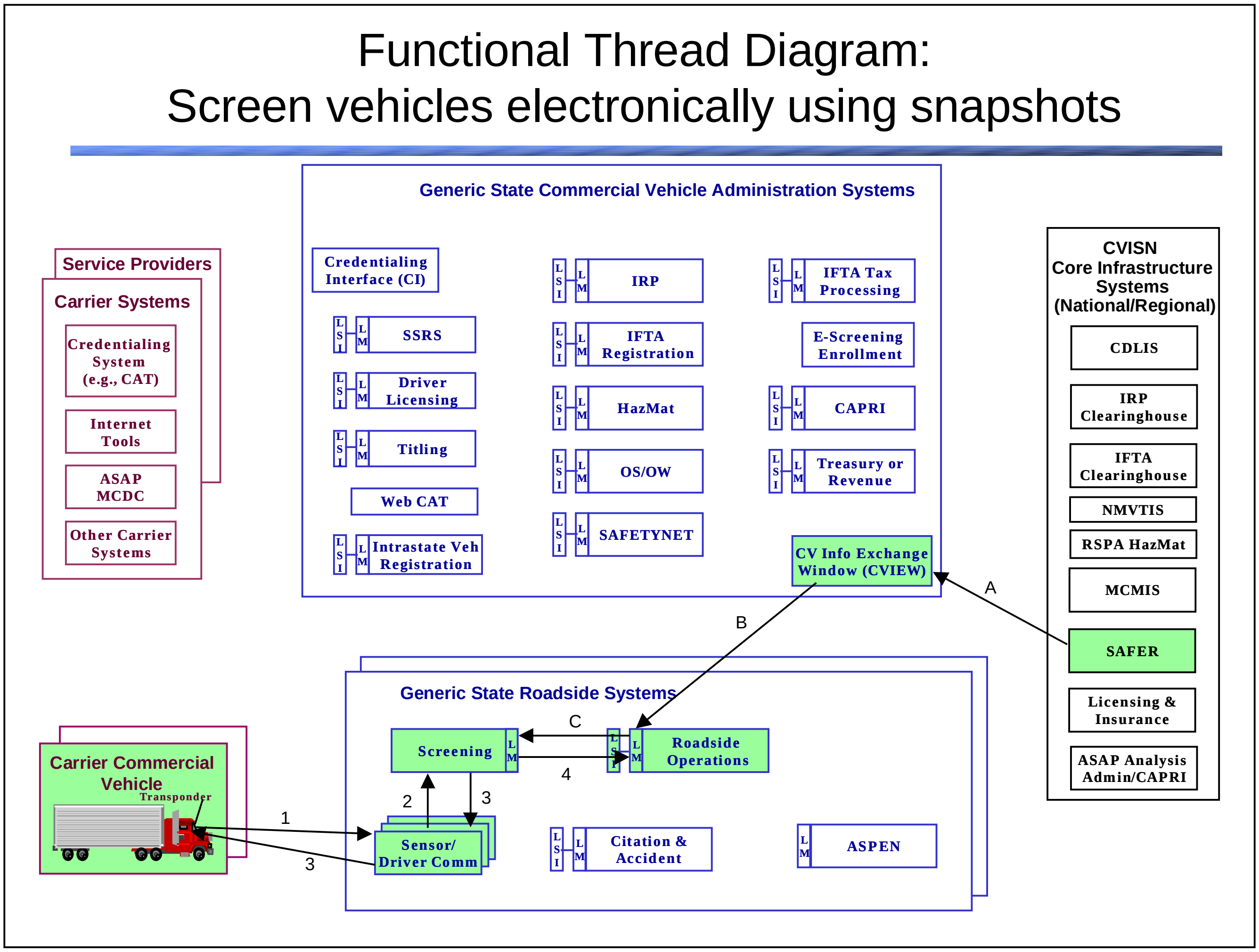

Figure 4–2. Screen Vehicles Electronically Using Snapshots

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